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THE PLANT FORMATIONS OF THE BERMUDA ISLANDS.

BY JOHN W. HARSHBERGER, PH.D.

No phytogeographic sketch has ever been published of this region, which comprehends the archipelago of larger and smaller islands lying south of the Gulf Stream in the western Atlantic between $32^{\circ} 14'$ and $32^{\circ} 23'$ N. Latitude and $64^{\circ} 38'$ and $64^{\circ} 53'$ W. Longitude, thus being about 600 miles from the nearest land, Cape Hatteras in North Carolina. It is evident from a study of the composition of the Bermuda flora that it is of comparatively recent introduction. Briefly, says Hemsley,¹ "it is not of purely West Indian origin, but was derived from the West Indies and that region of southeastern North America where the West Indian and North American types of vegetation overlap each other." There being no running streams, the original flora of Bermuda was essentially of a xerophytic type. The islands have been settled so long that the character of the original vegetation has been altered, and we must infer from the appearance of the flora at the present what its condition was when Bermuda was first discovered. The following formations, according to the observations of the writer in June, 1905. may be distinguished.

MARINE ALGAL FORMATION.

The marine algæ of Bermuda are mainly those which have accustomed themselves to living on a shore composed of limestone rocks (reef rocks, or eolian rocks) exposed to the action of the surge, or which live in limestone, or coral sand in the comparatively placid water of salt water lakes, bays, or lagoons.

According to my observations the algæ of the rocks exposed to the surge are *Sargassum bacciferum*, *Dictyota Barteyresiana*, *Halimeda tridens*, *H. tuna*, *Zonaria lobata*, *Haliseris polypodioides*, *Anadyomene flabellata*, *Codium tomentosum*, *Neomeris dumetosus*, *Ulva lactuca*, *U. latissima*, *Rhodymenia palmata*, *Padina pavonia*, *Galaxaura rugosa*, *G. lapidescens* and others. Those of the tidal pools formed in the rock hollows are: *Padina pavonia*, *Digenia simplex*, *Acetabularia cren-*

¹ HEMSLEY, W. BOTTING: Report on the Botany of the Bermudas. *Challenger Report. Botany*, I, p. 14.

ulata, *Caulerpa mexicana*, *C. racemosa uvifera*, *Ulva lactuca*, etc. The sandy bottoms beneath mangrove trees or in the channels leading from salt water sounds or ponds to the sea are characterized by *Halimeda tridens*, *Penicillus capitatus*, *Caulerpa taxifolia*, *C. cupressoides lycopodium*, *Padina pavonia*. The salt-water ponds, especially at Walsingham, are fed by underground channels, so that the water in them rises and falls with the tide. Here grow several interesting marine algæ, such as *Valonia utricularis*, *Caulerpa plumaris*, *C. racemosa*, and *Colpomenia sinuosa*.

MANGROVE SWAMP FORMATION.

The mangrove swamps occur at the heads of bays, especially along the south shore of the Bermudas and in the salt-water ponds which are here and there found distributed over the islands. The vegetation consists either of a pure growth of *Rhizophora mangle* with its prop roots extending in all directions, or a pure growth of *Avicennia nitida* (in flower in June) with its numerous pencil-like root knees projecting through the sticky mud at low tide. In some places, as in Castle Harbor, both *Avicennia nitida* and *Rhizophora mangle* are in association, and frequently one finds arising from the mud the green brush-like tops of *Penicillus capitatus*. Little else grows beneath the dense shade formed by the overarching crowns of these trees. Frequently a morass is formed by either *Rhizophora* or *Avicennia* taking possession of a shallow inland pond which thus becomes a swamp. Several such swamps are found near the coast on the north shore of Bermuda where *Avicennia nitida* has taken possession and has excluded everything else, except *Pluchea purpurascens*, *Sesuvium portulacastrum*, *Salicornia fruticosa*, *Heliotropium curassavicum* and a low sedge. In the salt-water pools in such swamps at Shelly Bay is found *Ulva lactuca*, and on the projecting roots of *Avicennia nitida* a moss-like growth of considerable bushiness.

SALT MARSH FORMATION.

This is found at the head of bays and elsewhere where the soil is influenced by the tides. In such a marsh along Harrington Sound the writer noted *Salicornia fruticosa*, *Heliotropium curassavicum*, *Sesuvium portulacastrum* and a number of sedges. The projecting roots from a single tree of *Avicennia* were also observed together with the long upright culms of a form of the crabgrass, *Stenotaphrum americanum*. The rare *Statice Lefroyi* also is a salt marsh plant.

BRACKISH MARSH FORMATION.

This exists in depressions some distance inland where marshes occur such as Smith's Parish Marsh, Devonshire Marsh, Pembroke Marsh all of which were investigated by me. Smith's Parish Marsh is devoid of trees. Here in the soil rendered brackish by underground channels grow *Typha angustifolia* in pure association, *Baccharis heterophylla* in thickets (Baccharis Association,) *Dichromena leucocephala*, *Scirpus lacustris*, while *Osmunda cinnamomea* is frequent. *Acrosticum aureum* forms pure associations at the edge of this marsh.

Devonshire Marsh is a large area with a few pools of water in the depressions. It gives evidence that it was once a pond. *Juniperus bermudiana*, *Sabal Blackburniana* and *Baccharis heterophylla* have encroached on this marsh so as to shade it. On the ground in the wettest places, according to Coulter,² are *Hydrocotyle asiatica*, *Herpestis monniera*, *Mentha viridis* and a white bracted sedge, *Dichromena leucocephala*. On the drier ground, *Osmunda regalis* and *O. cinnamomea* become abundant, while in the still drier peaty soil, according to my observations, *Pteris* (*Pteridium*) *aquilina caudata* is growing vigorously. Here also occur two other plants, *Cladonia* and *Leucobryum*. *Typha angustifolia* is in some places in pure association. *Acrosticum aureum* also forms pure association here and there in this marsh. The pools are occupied by two species of Sphagnum, *Proserpinaca palustris* and *Lemna minor*. Pembroke Marsh is characterized by somewhat similar associations of plants; but in addition to the plants noticed above, Governor Lefroy³ mentions several other plants peculiar to it, such as *Nasturtium officinale* (in water channels), *Ascyrum crux-andreae*, *Kosteletzkya virginica*, *Waltheria americana* (= *indica*), *Eclipta erecta*, *Pluchea odorata*, *Ceratophyllum demersum*, *Kyllinga monocephala*, *Scirpus validus*, *Cladium occidentale* (= *germanicum*) and *Spiranthes brevifolius*, the only orchid of Bermuda. The omnipresent cedar is found along the edge of this marsh together with *Sabal Blackburniana* which invades it. In a small pool grows *Lemna minor*.

SAND DUNE FORMATION.

Sand dunes occur typically along the south shore of Bermuda at the head of reëntrant bays between stretches of rocky coast. Several low dunes are found on the north shore as at Shelly Bay. The middle

² COULTER, SAMUEL MONDS: An ecological Comparison of some typical Swamp Areas, *Fifteenth Report Missouri Bot. Garden*, 1904, p. 62.

³ LEFROY, GENERAL SIR JOHN HENRY: The Botany of Bermuda, *Bulletin U. S. National Museum*, No. 25. 1884.

beach is covered with masses of *Sargassum*, washed ashore at high tide. The upper beach at the foot of the dunes is characterized by the presence of *Cakile æqualis*, occasional clumps of *Tournefortia gnaphalodes*, *Scævola Plumieri* and *Croton maritimus*. *Ipomæa pes-capræ* sends its long runners down from the slopes of the dunes, associated with *Scævola Plumieri*, *Stenotaphrum americanum*. A little back of the crest of dunes are found *Tournefortia gnaphalodes*, *Ipomæa pes-capræ*, *Scævola Plumieri*, *Juniperus bermudiana* (wind-swept form), *Sisyrinchium bermudianum*, *Lepidium virginicum*, *Euphorbia buxifolia*, *Canavalia obtusifolia*, *Opuntia vulgaris*. On the dunes at Tuckertown, *Scævola Plumieri* forms extensive tracts in pure association (*Scævola* Association). *Solidago sempervirens*, as in the eastern United States, is also a dune plant, together with the glaucous and hairy forms of *Borrichia arborescens* and *Dodonæa viscosa*. *Conocarpus erectus* forms thickets which in some places protects the dune crest. Here we have a mangrove plant occurring on sand dunes under perhaps similar ecologic conditions as in salt water. *Stenotaphrum americanum* forms mats on the lee slopes and a tall fennel, *Fæniculum vulgare*, is also very abundant.

The dunes in Paget on the south shore are high, but since the settlement of the country they have been captured by the encroachment of various exotic plants such as *Nerium oleander*, *Lantana camara*, *L. crocea*, while *Croton maritimus*, *Canavalia obtusifolia*, *Dodonæa viscosa*, *Borrichia arborescens* and *Passiflora suberosa* are among the more important native plants. *Yucca aloifolia* forms clumps on low sandy hills at Shelly Bay in association with *Ipomæa pes-capræ*, *Tournefortia gnaphalodes* and *Opuntia* sp.

CLIFF ROCK FORMATION.

The coast line of Bermuda is generally rocky and the waves have honeycombed the rocks into jagged forms with sea caves hollowed out beneath. These rocks support a characteristic vegetation consisting of the hairy and smooth forms of *Borrichia arborescens*, prostrate trees of *Conocarpus erectus*, clumps of *Solidago sempervirens*, *Lantana involucrata*, *L. Camara*, *Euphorbia buxifolia*, the crabgrass, *Stenotaphrum americanum* (covering all the available soil on the rocks), while wind-swept trees of *Juniperus bermudiana*, *Yucca aloifolia* and dwarf palmettos *Sabal Blackburniana*, also abound in some places. *Coccoloba uvifera* in Bermuda seems to prefer the rocky shores to those of the sand. *Sesuvium portulacastrum* and *Lippia nodiflora* are also rock plants

while in one place I collected the introduced *Linaria elatine* trailing over the ground on the limestone rocks.

CEDAR FOREST FORMATION.

This formation has been dignified by the name of forest, although no true forest exists on the islands, for the reason that the growth of the cedar trees *Juniperus bermudiana* is too open and the trees are not tall and dominant in the forest sense. All of the hillsides and hill summits not under cultivation are covered with the cedar *Juniperus bermudiana* with the admixture of *Sabal Blackburniana*. This species of juniper is a rapid growing one and reaches a merchantable size (two to three feet in diameter), but it differs from the eastern American species (*J. virginiana*) in branching more freely. It produces fruit in abundance. It is hard to determine the character of the original undergrowth. Now it consists of two species of *Lantana* (*L. involucrata*, *L. camara*), the prevailing *Nerium oleander*, *Lippia nodiflora*, *Solidago sempervirens* and *Sisyrinchium bermudianum*. The rock crevices are filled with a delicate endemic fern, *Adiantum bellum*. *Bryophyllum calycinum* (the floppers of the natives) is perhaps the most abundant plant in the undergrowth. It is found in all parts of the islands. The ground beneath the cedars is carpeted with the crabgrass *Stenotaphrum americanum* in the absence of other plants. Here and there the botanist meets with an introduced tree, such as *Citharexylum quadrangulare*, *Buddleia americana*, *Crescentia cujete*, *Hura crepitans*, *Duranta Plumieri*, which together with certain weeds enter into this formation and change its constitution. In abandoned cellars surrounded by cedars, one frequently sees *Ficus carica*, *Nicotiana glauca*, *Bryophyllum calycinum*, etc.

LIMESTONE SINKS FOREST FORMATION.

The so-called Walsingham Tract and several places near Harrington Sound on the south shore are characterized by the presence of numerous depressions, or sinks, as well as several caves. The Walsingham Tract, a narrow ridge of land about two miles long, and from a quarter to half a mile wide, which separates Castle Harbor from Harrington Sound, contains within its bounds nearly the whole of the indigenous flora of the islands. The following list of plants given by Lefroy includes plants of West Indian origin and their survival on the Bermudas is, I think, due to their growth in the limestone depressions many feet below the general surface, protected from the cutting blasts

of the ocean breezes, and in situations where the soil moisture is greater than on the surface of the hills above.

| | |
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| <i>Ampelopsis</i> (<i>Parthenocissus</i>) | <i>Asplenium crenulatum</i> |
| <i>quinquefolia</i> | <i>Callicarpa ferruginea</i> |
| <i>Asplenium myriophyllum</i> | <i>Dodonæa viscosa</i> |
| <i>Chiococca racemosa</i> | <i>Eugenia axillaris</i> (= <i>monticola</i>) |
| <i>Elæodendron xylocarpum</i> | <i>Caesalpinia</i> (<i>Guilandina</i>) <i>bonducella</i> |
| <i>Forestiera porulosa</i> | <i>Jasminum gracile</i> |
| <i>Ipomæa purpurea</i> | <i>Passiflora ciliata</i> (= <i>fætida</i>) |
| <i>Jatropha curcas</i> | <i>Psilotum triquetrum</i> |
| <i>Peperomia obtusifolia</i> | <i>Pteris heterophylla</i> |
| <i>Psychotria undata</i> | <i>Trema</i> (<i>Sponia</i>) <i>Lamarckiana</i> |
| <i>Sicyos angulatus</i> | <i>Xanthoxylum Clava-Herculis</i> |
| <i>Triumfetta semitriloba</i> | |

According to my observations the following trees form a large part of the vegetation of one of the sinks: *Celtis mississippiensis*, *Citrus limonium*, *Ficus carica*, *Musa Cavendishii* (planted), *Melia azederach*, *Lantana camara*, *L. involucrata*, while *Stenotaphrum americanum* abounds and *Asplenium trichomanes* together with *Rhus toxicodendron* are found on the sloping sides of such depressions. Two vines are abundant and loop themselves across the trees, viz., *Cardiospermum halicacabum* and *Jasminum gracile*. *Commelina agraria* (= *nudiflora*) also occurs in such sinks.

At Walsingham, *Juniperus bermudiana* prevails mixed with *Sabal Blackburniana*, *Celtis mississippiensis*, *Citharexylum quadrangulare*, *Calophyllum calaba*, etc., while the trees are festooned with *Jasminum gracile*, *Rhus toxicodendron* and *Ipomæa purpurea*. *Peperomia obtusifolia* and several ferns are found on the rough rocks in the bottom of the sinks, together with *Bryophyllum calycinum* and one or two species of *Lantana*. *Citrus limonium* and *Musa Cavendishii* are also present in this jungle of plants.

SCRUB FORMATION.

This formation is due to the hand of man. After the cedars are cut down, if the land is neglected and allowed to stand without cultivation it is covered by a growth of several species of *Lantana*, *L. camara* and *L. involucrata*. *Bryophyllum calycinum* also abounds together with many introduced weeds and thickets of *Nerium oleander*. Many of the hillsides in Bermuda are covered with this worthless scrub. Later perhaps under favorable conditions *Juniperus bermudiana* appears, but the flora is never restored to its original condition because the sage bush plants always form an important constituent of the undergrowth.